REMARKS

Prior to an examination of the present application, Applicants respectfully request entry of this Preliminary Amendment. Applicants submit that no new matter has been added.

Attached hereto is a marked-up version of the changes made to the application by the current amendment. The attached page is captioned "**Version with markings to show changes made.**"

Respectfully submitted,

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OPTICAL DISC, RECORDING APPARATUS, AND COMPUTER-READABLE RECORDING MEDIUM

BACKGROUND OF THE INVENTION

(1) Field of the Invention

This invention relates to an optical disc used for recording video data, a recording apparatus, and a computer-readable recording medium recording a file management program.

(2) Description of the Prior Art

Recently, optical discs such as CD-ROMs and DVD (Digital Versatile Disc)-ROMs have been used for recording video data (also called AV data in this document) of movies or the like, as well as being used as secondary storages for computers. Currently, practical uses of DVD-RAMs are awaited because of the ~~waited for due to~~ general expectation that DVD-RAMs will be popular as the main recording medium of the next generation.

First, conventional DVD-ROMs are explained in terms of special reproductions. The special reproductions include fast forwarding or rewinding AV data at a speed n times as high as the normal reproduction speed (hereinafter such a speed is called n-speed).

The AV data to be recorded in DVD-ROMs is compressed with a compression encoding method at a variable bit rate to increase the compression rate. The "variable bit rate" means that

the amount of compressed image data per one frame is variable. As a result, the amount of compressed data is not proportionate to the reproduction period. When this happens, even if the coded AV data is read out at steady intervals, that is at every predetermined size of the coded AV data, the read-out AV data does not correspond to images to be sectioned per predetermined time period.

To relate the amount of compressed data to the reproduction period, information of each special reproduction is inserted into necessary points in the AV data in DVD-ROMs.

More specifically, the AV data is compressed in compliance with MPEG2. Through the compression, information called NV pack which is unique to DVD is added to the start of each GOP (Group Of Pictures). GOPs are sections which each have a period of 0.4 to 1.0 seconds. Exceptionally, an end of a VOB (Video OBject) has a GOP of 1.2 seconds. Data included between one NV pack and the next NV pack is called VOBU (Video OBject Unit).

Each NV pack includes 2K-bytes of information used for referring to adjacent NV packs. Each NV pack also includes the data size of the first reference picture in a GOP. The information used for referring to adjacent NV packs is composed of relative addresses of NV packs of VOBUs in the forward and backward directions ~~of~~ separated by a predetermined time period from the current VOBU, the relative addresses being obtained based on the start time code of the current VOBU. The predetermined time

period may be one to 15, 20, 60, 120, and 240 seconds.

Secondly, operations of special reproductions such as fast forwarding and rewinding are described. The special reproductions substantially at a steady speed are attained by reproducing only the reference pictures of VOBUs having a predetermined time interval in between, in accordance with the reproduction speed. To sequentially read out the VOBUs having a predetermined time interval in between, the information used for referring to adjacent NV packs in each NV pack is used.

A time search map is recorded in every time code that is arranged with a predetermined time interval in between from the start of the AV data. The time search map indicates an address of a piece of AV data in the VOBU corresponding to the current time code. By referring to the time search maps, reproduction apparatuses can start reproducing the AV data starting from the specified time codes.

However, it has been impossible to apply the method of inserting the special reproduction information into AV data to real-time recording of data into recording mediums such as DVD-RAMs.

This is because in real-time recording of AV data, information on a part of the AV data to be recorded from now on (e.g., addresses of NV packs in the backward direction) cannot be obtained.

Also, it is possible to generate special reproduction

information to be recorded in each NV pack after the AV data is recorded. However, to record the generated information into an AV data storage area as NV packs, the same number of accesses to the disc as the number of VOBUs are required. This cannot be achieved in real time.

Some may think that this problem will be solved by storing the AV data and the special reproduction information in different AV data areas. However, this solution has another problem that to store the special reproduction information in a main memory, the main memory should have a large capacity, where the storage of the special reproduction information in the main memory is necessary to execute the special reproductions at high speed.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide an optical disc recording apparatus for generating special reproduction information of reduced amount while AV data is recorded onto the disc in real time, and an optical disc onto which data is recorded by the optical disc recording apparatus.

The above object is achieved by an optical disc including a data area and a time map area, the data area storing one or more video objects and the time map area storing time map information, where each video object includes a plurality of video object units, the time map information includes ~~a pair of~~ a first

i.e., a pair of time tables,

time table and a second time table for each video object, each first time table includes: addresses of video object units in a corresponding video object, the addresses being arranged in order and indicating storage positions of the video object units that correspond to reproduction points that differ by a predetermined time unit, the predetermined time unit being longer than a maximum reproduction period of a video object unit; and indicators for specifying the video object units which respectively correspond to the addresses, and each second time table includes an entry for each video object unit in the corresponding video object, the entries being arranged in order and each including a reproduction period of a video object unit and a data size of the video object unit.

With the above construction, the first time table has a small size since the first time table only records storage positions of video object units at predetermined intervals. For the second time table, it is not required to record a storage position of each video object unit in relation with a reproduction point. The second time table also includes a reproduction period and a data size for each video object unit. As a result, the second time table has also a small size since the reproduction period is smaller than the data size ~~in size~~. It is very easy to generate the second time table while data is recorded onto the disc since the second time table is recorded in units of video object units which are the unit of encoding.

In the above optical disc, each first time table may include a plurality of first time maps which each correspond to a different one of the reproduction points, and each second time table may include a plurality of second time maps which each correspond to a different one of the plurality of video object units, and each first time map includes: one of the indicators, the indicator indicating a second time map for a video object unit that corresponds to the reproduction point, an address of the video object unit that corresponds to the reproduction point, and difference information indicating a difference between the corresponding reproduction point and a reproduction start time of the corresponding video object unit, and each second time map includes time information indicating a reproduction period of a corresponding video object unit, and also includes a data size of the corresponding video object unit.

In the above optical disc, the time map information may include a time offset for each video object, each time offset indicating a difference between a first reproduction point during a reproduction of the corresponding video object and a start time of a first video object unit in the corresponding video object.

With the above construction, it is possible to correct the time map information without difficulty by changing the value of the time offset even if the first part of a video object is cut by editing.

The above object is also achieved by a recording

apparatus including: an input unit for receiving video data in a time series; a compression unit for compressing the received video data to generate a video object which includes a sequence of video object units; a write unit for writing data onto an optical disc; and a control unit for controlling the write unit, where the control unit controls the write unit to write the generated video object onto the optical disc, generates a first time table and a second time table, and controls the write unit to write the generated first time table and second time table, each first time table ~~including~~ includes: addresses of video object units in a corresponding video object, the addresses being arranged in order and indicating storage positions of the video object units that correspond to reproduction points that differ by a predetermined time unit, the predetermined time unit being longer than a maximum reproduction period of a video object unit; and indicators for specifying the video object units which respectively correspond to the addresses, and each second time table ~~including~~ includes an entry for each video object unit in the corresponding video object, the entries being arranged in order and each including a reproduction period of a video object unit and a data size of the video object unit.

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position of each video object unit in relation with a reproduction point. The second time table also includes a reproduction period and a data size for each video object unit. As a result, the second time table has also a small size since the reproduction period is smaller than the data size ~~in size~~. It is very easy to generate the second time table while data is recorded onto the disc since the second time table is recorded in units of video object units which are the unit of encoding.

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In the above recording apparatus, the time map information may include a time offset for each video object, each

unused area being provided to prevent mistaken identification of sector addresses. This is because while sector addresses are recorded at a same position in adjacent tracks within the same zone, for Z-CLV the sector addresses are recorded at different positions in adjacent tracks at the zone boundary.

In this way, sectors which are not used for data recording exist at the boundaries between zone areas. Therefore, on a DVD-RAM, logical sector numbers (LSN: Logical Sector Number) are assigned to physical sectors of the user area in order starting from the inner periphery to consecutively show only the sectors used for recording data.

As shown in FIG.3C, the area that records user data and is composed of sectors that have been assigned LSNs is called volume area.

Also, as shown in FIG.3D, in the innermost and outermost peripheries, volume structure information is recorded to be used to deal with the disc as a logical volume. The rest of the volume area except the areas for recording the volume structure information is called partition area. The partition area records files. The logical block numbers (LBN: Logical Block Number) are assigned to sectors of the partition area in order starting from the first sector.

FIG.4 shows a hierarchical relation between zone areas, ECC blocks, and sectors. As shown in the drawing, each zone area includes a plurality of ECC blocks. It should be noted here that

in the optical discs, areas in units of sectors are assigned to non-AV data, while areas in units of consecutive recording areas are assigned to AV data so that each consecutive recording area secures uninterrupted reproduction of the AV data. Here, each consecutive recording area is composed of consecutive sectors in units of ECC blocks (in other words, each area is an integral multiple of an ECC block) and has a predetermined size (about 7MB) or more, each consecutive recording area not outstepping the boundary between zones. However, when the AV data includes a plurality of extents, the last extent may be smaller than the predetermined size. The reason why it is defined that each consecutive recording area does not outstep the boundary between zones is that an outstepping of the boundary will change the rotation angular velocity of the optical disc, which will disturb the uninterrupted reproduction. The reason why each consecutive recording area is an integral multiple of an ECC block is that the ECC block is the minimum unit dealt with in the ECC process.

FIG.5 shows a sector management table (space bit map) and a consecutive recording area management table. The sector management table is recorded in the partition area of the volume area and is included in the file system management information. The consecutive recording area management table is used to manage the consecutive recording areas. The drawing also shows a hierarchical relation between the volume area, sectors, and contents of the sectors.

The first layer shows the volume area shown in

The second time table (VOBU table) is composed of VOBU maps #1, #2, ... which include: reproduction periods and data sizes of the VOBUs, the VOBU maps being arranged in the order of reproduction of the corresponding VOBUs starting from the start of the current VOB.

The PGC information table 830 includes a plurality of pieces of PGC information 831, 832, ...

The plurality of pieces of PGC information 831, 832, ... are each a table which includes a list of video sections in VOBs, the sections being arranged in the reproduction order. The information specifying the video section are called cells. Each cell specifies a video section in a VOB by its start time and end time. Each piece of PGC information shows logically linked video sections of AV data specified by the cells.

Each of the cells 831a, 831b, ... includes an AV file identifier, a VOB identifier, and a ~~pair of~~ start time and ~~an~~ end time of a video section.

In the example shown in FIG.9, a sequence of AV data corresponding to a title is identified following the coarse of: title search pointer 811→PGC information 831→cells 831a to 831c→VOB information 821, 822→VOBs #1, #2. In this example, the AV data corresponding to a title is composed of two VOBs #1, #2. The most simplest example of PGC information, such as the case of a newly recorded title, is represented as: one title→one piece of PGC information→one cell→one piece of VOB information→one VOB.

The time maps 8211, 8212, ... each include a VOBU map number, a time difference (also referred to as TM_DIFF), and a VOBU address (also referred to as VOBU_ADR).

The VOBU map number 8212a is a VOBU map number which corresponds to the time map time of the time map 8212.

The TM_DIFF 8212b is a time difference between the start time of the current VOBU and the corresponding time map time. The start time of VOBU #j is represented as:

VOBU START TIME = (TMU*(j-1)+TM_OFS-TM_DIFF).

The VOBU_ADR 8212c is an address (a sector address of four bytes) indicating the start of a VOBU.

The VOBU table 8230 is a table including VOBU maps 8231, 8232, ... which respectively correspond to the VOBUs included in the current VOB.

The VOBU maps 8231, 8232, ... each include a reference picture size, a VOBU reproduction time, and a VOBU size.

The reference picture size 8232a is a size of the first I-picture of a VOBU. The size 8232a is used for reading a reference picture in the performances of special reproductions and reproductions at specified times.

The VOBU ~~reproduction~~ reference time 8232b is a period for which a VOBU is reproduced. The time 8232b is represented with one byte. The time 8232b is used for detecting a target image in the performances of special reproductions and reproductions at specified times. That is to say, the reproduction apparatus

continues to add each VOBU reproduction time to the VOBU start time in sequential order until the addition result matches the time of the VOBU corresponding to the target image. The reproduction apparatus detects the target VOBU and then further detects the target image from the detected VOBU.

The VOBU size 8232c is a data size of a VOBU. The VOBU size 8232c having two bytes indicates the VOBU size by the number of sectors. The size 8232c is used for detecting the size of the target image in the performances of special reproductions and reproductions at specified times.

(2) Recording/Reproduction Apparatus

The optical disc recording/reproduction apparatus of the present invention is described with reference to the drawings.

(2-1) Entire System

FIG.14 shows the construction of a system including the optical disc recording/ reproduction apparatus of the present embodiment.

The system includes an optical disc recording/ reproduction apparatus 10 (also referred to as DVD recorder 10), a remote controller 6 used for operating the DVD recorder 10, a DVD recorder display 12 connected to the DVD recorder 10, and an antenna 11.

After the DVD-RAM disc is loaded, the DVD recorder 10

compresses the video/audio data which is included in the analog broadcasting waves which is received through the antenna 11, records the compressed data as AV files into the DVD-RAM disc, expands the compressed video/audio data, and outputs the expanded video/audio signals onto a display 12.

(2-2) Hardware Structure of DVD Recorder 10

FIG.15 is a block diagram showing the hardware structure of the DVD recorder 10.

The DVD recorder 10 includes a control unit 1, an MPEG encoder 2, a disc access unit 3, an MPEG decoder 4, a video signal processing unit 5, a remote controller 6, a bus 7, a remote controller signal receiving unit 8, and a receiver 9.

The control unit 1 includes a CPU 1a, a processor bus 1b, a bus interface 1c, and a main memory 1d. The control unit 1 executes a program stored in the main memory 1d to control the entire DVD recorder 10 in terms of recording, reproducing, editing, etc. Especially, after an AV file (VOB) including AV data is recorded, the control unit 1 generates VOB information and PGC information corresponding to the recorded VOB, and records or updates the AV data management file. Also, when the AV data is reproduced, the control unit 1 obtains, based on the VOB information, the address of a section specified by its start and end times in a cell included in the PGC information in the AV data management file shown in FIG.9. The control unit then reads out

and reproduces the section. Especially, in case of special reproductions, the control unit 1 refers to the VOB information to sequentially obtain addresses of reference pictures which are arranged at intervals of a predetermined period (e.g., 5 seconds or -5 seconds), for fast forwarding or rewinding.

The MPEG encoder 2 compresses the video/audio data which is included in the analog broadcasting waves received through the antenna 9 and generates an MPEG stream.

The disc access unit 3, having a track buffer 3a, under the control of the control unit 1, records the MPEG stream received from the MPEG encoder 2 into the DVD-RAM disc via the track buffer 3a, reads out the MPEG stream from the DVD-RAM disc, and outputs the read MPEG stream to the MPEG decoder 4 via the track buffer 3a.

The MPEG decoder 4 expands the compressed MPEG stream which is read out by the disc access unit 3, and outputs the expanded video data and audio signals.

The video signal processing unit 5 converts the video data output from the MPEG decoder 4 into video signals for the display 12.

The remote controller signal receiving unit 8 receives remote controller signals from the remote controller 6 and informs the control unit 1 of which operation the user has instructed.

The DVD recorder 10 is, as shown in FIG.14, constructed based on the premise that it is used as a replacement for a VTR

As shown in FIG.19, the DVD recorder 10 is composed of a disc recording unit 100, a disc reading unit 101, a file system unit 102, a recording/ editing/ reproducing control unit 105, a user IF unit 106, a control data management unit 107, an AV data recording unit 110, an AV data editing unit 120, and an AV data reproducing unit 130.

The disc recording unit 100, on receiving a logical sector number and logical data in units of sectors from the file system unit 102, records the received logical data onto the disc. However, in reality, the disc recording unit 100 reads and writes the logical data in units of ECC blocks (each block composed of 16 sectors) from and onto the disc. If the logical data has less than 16 sectors, the disc recording unit 100 reads the ECC block including the logical data, executes the ECC process, then writes the ECC block onto the disc.

The disc reading unit 101, on receiving a logical sector number and the number of sectors from the file system unit 102, reads data from the specified sectors and transfers the read data to the file system unit. However, in reality, the disc reading unit 101 reads data in units of ECC blocks. After the read data is ~~executed~~ subjected to the ECC process, the disc reading unit 101 transfers only necessary data in sectors to the file system unit. This is because by reading AV data in units of ECC blocks (each block composed of 16 sectors), overhead is reduced. This is the same with the disc recording unit 100.

The file system unit 102 includes an AV file system unit 103 for mainly writing and editing AV files, and a common file system unit 104 for executing processes common to AV files and non-AV files. The file system unit 102, on receiving commands from the AV data recording unit 110, AV data editing unit 120, and AV data reproducing unit 130 in relation to writing or reading files, manages files on the optical disc in units of sectors at the minimum.

The recording/ editing/ reproducing control unit 105 controls the entire DVD recorder 10. More specifically, the control unit 105 controls display of guidance which urges the user to operate, receives instructions from the user reacting to the guidance via the user IF unit 106, and, in accordance with the user instructions, requests the AV data recording unit 110, AV data editing unit 120, or AV data reproducing unit 130 to execute operations such as newly recording of AV data, and reproducing and editing of recorded AV data.

The user IF unit 106 receives instructions for operations from the user via the remote controller 6, and ~~informs~~ sends the received user instructions to the recording/ editing/ reproducing control unit 105.

The control data management unit 107 reads the AV data management file which is non-AV data ~~onto~~ from the main memory 1d, and provides information on request from any unit.

The AV data recording unit 110, on receiving a recording

memory.

The AV data recording unit 110, AV data editing unit 120, and AV data reproducing unit 130 achieves processes such as recording, editing, and reproducing by using combinations of the above commands.

(3) Recording/ Reproducing

Now, the operations of the DVD recorder 10 is described in detail. The operations are: (3-1) Recording of AV Files, (3-2) Generating and Recording of AV File Management Information, (3-3) Reproduction of AV Data, (3-4) Reproduction by Specified Time, and (3-5) Special Reproduction of AV Data.

(3-1) Recording of AV Files

For recording video/ audio data, a manual recording and a programmed recording are available. The manual recording immediately starts after the user presses the "Record" key on the remote controller and sets a few items for the recording. In the programmed recording, the start and end times of the recording is programmed by the user in advance.

For example, when the user presses the "Record" key on the remote controller 6, the display 12 displays a guidance image 200 as shown in FIG.21 under the control of the recording/ editing/ reproducing control unit 105. When the user presses "1" and "Selection" keys on the remote controller while the guidance

performed by the AV data recording unit 110.

In case of a manual recording, a notification that the user has pressed the "Record" button is sent to the recording/ editing/ reproducing control unit 105 via the user IF unit 106.

On receiving the notification, the control unit 105 assigns a consecutive recording area having a size greater than the predetermined size (about 7MB) which has been described earlier (step 220). More specifically, the control unit 105 refers to the space bit map and the consecutive recording area management table to detect not-assigned consecutive sector areas. The control unit 105 then assigns a new consecutive recording area composed of the not-assigned consecutive sector areas to the recording. In doing so, when other AV data has already been recorded in the disc and when the AV data to be recorded continues from the existent AV data logically, the control unit 105 assigns a consecutive recording area that continues from the already-assigned consecutive recording area of the existent AV data, if it is possible.

The recording/ editing/ reproducing control unit 105 sends a file identifier and a parameter indicating the "time-ensuring" quality specified as the recording condition to the AV data input unit 111. The AV data input unit 111 instructs the MPEG encoder 2 to start encoding the video and audio data of a predetermined channel received through the antenna 1 and to start transferring the encoded MPEG data to the track buffer 3a (step

221).

The recording/ editing/ reproducing control unit 105 issues the CREATE command specifying the newly assigned consecutive recording area to the common file system unit 104 (step 222). On receiving the command, the common file system unit 104 returns the file identification descriptor when it is possible to create a file in the newly assigned consecutive recording area.

While the above process is proceeding, the AV data input unit 111 issues the OPEN command to the AV file system unit 103 (step 223) to allow the AV file system unit 103 to store the file identification descriptor given by the control unit 105 and information on the file entry into a work memory (not illustrated) (the information stored in the work memory is also referred to as "Fd" (File descriptor).

The AV data input unit 111 calculates and stores the number of packs in each VOBU and the number of packs in the first reference picture (I-picture) in each VOBU into the main memory 1d as the GOP information each time a VOBU is encoded. The AV data input unit 111 continues to perform this process until it receives a stop instruction from the control unit 105 (step 224). FIG.23 shows an example of the GOP information. The drawing shows the GOP information stored in the main memory 1d at the time VOBUs up to VOBU #22 have been encoded. It should be noted here that in the present embodiment, each VOBU includes video data of 15 frames

(or 30 fields) which correspond to about 0.5 seconds of reproduction.

Furthermore, the AV data input unit 111 issues the WRITE command to the AV file system unit 103 every time the track buffer 3a stores a predetermined amount of MPEG data (steps 228 and 229). Here, it is presumed that the WRITE command is issued to the system unit 103 together with three parameters specified. The three parameters respectively indicate: the Fd having been opened by the OPEN command as described above; the size of data to be recorded; and a buffer (in this embodiment, the track buffer 3a) storing the data. The Fd specified by the parameter includes, as the file entry does, information of a storage position of an extent and a length of the extent. The information represents the consecutive recording area assigned in the step 220. The Fd is updated every time a write is issued during the period between the opening and closing of the Fd. For the second or a subsequent issue of the WRITE command, new data is additionally written, following the already-recorded data.

On receiving the stop instruction (step 224), the AV data input unit 111 issues the WRITE command (step 230). The AV data input unit 111 then issues the CLOSE command (step 231). The AV data input unit 111 further informs the AV file management information generating unit 112 that a recording of an AV file (VOB) has ended (step 232) to end the entire process. Note that the WRITE command is issued in step 230 to record onto the disc

the rest of the data in the track buffer. Also, the CLOSE command issued in step 231 is a command used to write back the Fd from the work memory onto the DVD-RAM disc as a file identifier, a file entry or the like on the DVD-RAM disc.

In the example shown in FIG.23, a manual recording case is described. In case of the programmed recording, a notification that the "Record" button has been pressed is sent to the recording/ editing/ reproducing control unit 105 via the user IF unit 106 together with a time specified for the programmed recording. The control unit 105 assigns a consecutive recording area corresponding to the specified time period.

(3-2) Generating and Recording of AV File Management Information

FIG.24 is a flowchart showing the process of generating and recording the AV file management information by the AV file management information generating unit 112.

As shown in the drawing, the AV file management information generating unit 112, on receiving from the AV data input unit 111 a notification that a recording of an AV file has ended (step 251), generates the VOB information based on the GOP information stored in the memory (main memory 1d) by the AV data input unit 111 and also based on the VOBU numbers corresponding to the start address of the newly assigned consecutive recording area storing the AV file (step 252). (a) The VOB general information and the time map information including, as shown in FIG.11,

(b)time map general information, (c) VOBU table, and (d) time map table are generated as follows.

(a) VOB General Information (VOB Identifier, VOB Reproduction Time)

When a file management table has already been held in the control data management unit 107, the AV file management information generating unit 112 assigns a not-assigned VOB identifier (e.g., the next VOB identifier). When a file management table has not been held in the control data management unit 107, the AV file management information generating unit 112 assigns VOB #1 as the VOB identifier, obtains the reproduction time of the AV file from the AV data input unit 111, and generates the VOB general information which includes these kinds of information.

(b) Time Map General Information (Number of Time Maps, Number of VOBU Maps, TMU, TM_OFS)

The AV file management information generating unit 112 calculates the number of time maps by dividing the VOB reproduction time by the TMU which is set to 60 seconds, for example. The AV file management information generating unit 112 then sets the number of VOBU maps to the number of VOBUs included in the GOP information, and sets the TM_OFS to "0" (in case of a new recording).

(c) VOBU Table (Reference Picture Size, VOBU Reproduction Time, VOBU Size)

repeated processes. When the instruction to end the special reproduction is entered (step 325), the AV data reproducing unit 130 ends the special reproduction process and returns to a former normal reproduction, that is, to step 283 shown in FIG.26 or step 296 shown in FIG.27 (step 326). In doing this, the time "ts" is set to the start time of the normal reproduction.

As described above, reference picture addresses corresponding to times which differ by the skip time are sequentially obtained in accordance with the time map information. Furthermore, the time map information includes the time map table and the VOBU table in a hierarchical structure in which the reproduction times of all the VOBUs and their storage positions (sector addresses) are related to each other. With this construction, it is unnecessary for the disc to record the reproduction times and storage positions (sector addresses) of all the VOBUs. This reduces the amount of data to be recorded in one disc, enabling video/audio data to be reproduced in realtime while the video/audio data is recorded onto the disc.

In the present embodiment, as shown in FIG.14, the DVD recorder 10 is constructed based on the premise that it is used as a replacement for a VTR used at home. However, not limited to the construction, when the DVD-RAM disc is to be used as a recording medium for computers, the following constructions are possible. That is to say, the disc access unit 3 is connected, as a DVD-RAM drive apparatus, to a computer bus via an IF called SCSI or IDE.

ABSTRACT OF THE DISCLOSURE

An optical disc including: a data area storing one or more video objects; and a time map area storing time map information. Each video object includes a plurality of video object units. The time map information includes ~~a pair of~~ a first time table and a second time table for each video object. Each first time table includes: addresses of video object units in a corresponding video object; and indicators. The addresses are arranged in order and indicate storage positions of the video object units that correspond to reproduction points that differ by a predetermined time unit. The predetermined time unit is longer than a maximum reproduction period of a video object unit. The indicators specify the video object units which respectively correspond to the addresses. Each second time table includes an entry for each video object unit in the corresponding video object. The entries are arranged in order. Each second time table includes a reproduction period and a data size of each video object unit.